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International Application No.: PCT/EP2004/051720
International Filing Date: August 5, 2004
Preliminary Amendment Accompanying
Substitute Specification

REMARKS

Drawings - Figure 5 has been amended and is presented herewith for approval.

The substitute specification enclosed herein contains no new matter.

The Director is authorized to charge any additional fees due by way of this Amendment, or credit any overpayment, to our Deposit Account No. 19-1090.

All of the claims remaining in the application are now clearly allowable. Favorable consideration and a Notice of Allowance are earnestly solicited.

Respectfully submitted,

SEED Intellectual Property Law Group PLLC



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Enclosures:

Postcard
1 Replacement Sheet of Drawings (Figures 3-5)
Redlined Substitute Specification
Substitute Specification

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Amendments to the Drawings:

The attached sheet of drawings includes changes to Figure 5. This sheet, which includes Figs. 3-5, replaces the original sheet including Figs. 3-5.

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1AP20 Rec'd PCT/PTO 03 FEB 2006

BEARING STRUCTURE

BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention concerns a bearing structure having the features of the classifying portion of claim 1 for a rotor blade of a wind turbine. In particular, the invention relates to a composite structure rotor blade. The invention further concerns a process for the production of a shaped body, in particular a
10 rotor blade, of a fibrefiber composite structure, comprising the following steps:
—producing shells forming the outer contour of the shaped body, —producing bearing structures of fibrefiber strands of predetermined length which are impregnated with a hardening composite material, and —transporting the bearing structure into the shells. The invention further concerns a rotor blade produced in
15 accordance with that process and a wind power installation having such a rotor blade.

Description of the Related Art

Such a A process has long been known in particular in the field of wind power and makes it possible to produce rotor blades with a dependable join
20 joining between the bearing structure and the shells forming the outer contour of the rotor blade as the same materials are used in each case.

In that respect, half-shell portions, for example of fibrefiber composite material such as glass fibrefiber and epoxy resin are produced, and these determine the external shape of the rotor blade. As such rotor blades perfectly
25 well often reach lengths of more than 50 metres, loads occur, which must be absorbed and dissipated. That is effected by way of the bearing structure provided in the rotor blade.

Such a known bearing structure comprises so-called what are
called roving webs. These involve strands of fibrefiber material such as carbon
fibrefiber or, preferably because of the low cost, glass fibrefiber. Those strands
extend in part continuously over the entire length of the bearing structure or the
5 rotor blade. The number of webs also increases with increasing proximity to the
rotor blade root in order to absorb and dissipate the higher loads by virtue of a
greater blade thickness and blade depth.

In order to achieve an adequate load-bearing capability, a suitably
large number of those roving webs is used. They are impregnated with a polymer
10 such as for example epoxy resin before being fitted into the prefabricated rotor
blade shell. It will be appreciated that the impregnation operation can be effected
equally by feeding the polymer from the outside and also by an injection process.
The impregnated roving webs are then fitted into the shell of the rotor blade at the
intended positions. As the rotor blade is made from the same material, there is an
15 excellent join between the shell and the roving webs.

As those roving webs are laid 'wet' in the shell however deformations
can easily occur in that procedure as those wet webs are not flexurally stiff. Such
deformations are also referred to as 'undulations' and after hardening result in a
spring effect at that location. That adversely affects the stiffness of the bearing
20 structure or the rotor blade.

In addition, hardening of the polymer is an exothermic process in
which heat is correspondingly given off to the exterior. In the case of bearing
structures comprising a large number of roving webs, a correspondingly large
amount of epoxy resin is also required in order to produce an adequate join. The
25 exothermic reaction is correspondingly intensive and the amount of heat given off
is correspondingly high.

As general state of the art attention is to be directed to DE 44 23 115
A1 and DE-AS No 1 264 266.

BRIEF SUMMARY OF THE INVENTION

Therefore the one object of the present invention is to develop a process of the kind set forth in the opening part of this specification such that the exothermic reaction is limited and the risk of undulations is reduced.

5 According to the invention, ~~that object is attained by a bearing structure having the features of claim 4~~ the claims and a process for the production of a shaped body having the features of ~~claim 3~~ the claims is provided.

~~Advantageous developments are set forth in the appendant claims.~~

 In accordance with the invention, ~~therefore~~ it is proposed that
10 prefabricated, flexurally stiff components are integrated into a bearing structure. In that respect the invention is based on the realisation that prefabricated components, even if they are ~~again~~ made up of a ~~fibrefiber~~ composite system such as carbon ~~fibrefiber~~ or glass ~~fibrefiber~~ webs and a polymer, are already hardened and thus permit a corresponding reduction in the material which is to be processed
15 wet, and thus lead to a reduced exothermic reaction. In addition those prefabricated components stiffen the wet constituents and thus contribute to reducing the undulations, that is to say the unwanted deformations of the ~~fibrefiber~~ strands.

 It will be appreciated that those prefabricated components can also
20 comprise any other suitable material. In that respect a further advantage of using prefabricated components is that they can be separately produced and subjected to quality control.

 The quality of those components, which is ensured in that way, and the low level of exothermy, also affords an overall improvement in the quality of the
25 bearing structures.

 Particularly preferably those prefabricated components are of a length which substantially corresponds to the length of the bearing structure to be constructed. That implements a continuous structure which also permits a continuous flow of force.

Advantageous embodiments of the invention are set forth in the
appendant claims.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

The invention is described in greater detail hereinafter with reference
5 to the Figures in which:

Figure 1 shows a simplified view in cross-section through a rotor
blade,

Figure 2 shows a simplified internal view of a rotor blade shell,

Figure 3 shows a simplified view of a known bearing structure,

10 Figure 4 shows a simplified view of a bearing structure according to
the invention,

Figure 5 shows a view on an enlarged scale in cross-section of a
prefabricated component according to the invention, and

Figure 6 shows an alternative embodiment of a bearing structure
15 according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Figure 1 shown therein in simplified form in cross-section
is a rotor blade 10 for a wind power installation. That rotor blade includes an upper
shell 11 and a lower shell 12. Provided in those shells 11 and 12 are bearing
20 structures 14, 16 which absorb and dissipate the loads acting on the rotor blade
10.

Figure 2 is a simplified inside view of such a shell 11, 12. Provided
at a predetermined position of a shell 11, 12 is a bearing structure 14, 16 which
extends over the entire length of the shell 11, 12 and thus over the entire length of
25 the rotor blade produced therefrom.

Figure 3 once again shows in simplified form the structure of a known
bearing structure 14, 16. That bearing structure is formed from ~~fibrefiber~~ strands

or bundles 20, ~~so-called~~ sometimes called roving webs, which are enclosed by an epoxy resin 22. It will be appreciated that that ~~fibrefiber~~ material for the fiber strands 20 can be a carbon ~~fibrefiber~~, glass ~~fibrefiber~~ or any other suitable ~~fibrefiber~~. It is also to be noted that the round bundling of the roving webs 20, which is shown in this Figure, only serves for illustration purposes. In reality the bundles can be of any desired shape.

It can already be clearly seen in this Figure that ~~such-a~~ (wet) arrangement of webs 20 and epoxy resin 22 is ~~always~~-subject to the risk of deformation, ~~so-called~~ undulations, ~~precisely~~ particularly with the considerable lengths involved.

Figure 4 shows an embodiment according to the invention of a bearing structure 14, 16. This bearing structure 14, 16 also has roving webs 20 which are embedded in the epoxy resin 22. A plurality of prefabricated components 24 that are flexurally stiff are integrated with the fiber composite structure to form the bearing structure 14, 16. It will be noted ~~however~~-that it is possible to clearly see here the prefabricated components 24 which are inserted into the bearing structure 14, 16 according to the invention. They can extend over the entire length and form layers which are capable of bearing and supporting the roving webs 20.

As the prefabricated components 24 are fully formed, dried and solid, they already exhibit their final flexural stiffness, and therefore, they form a support structure which prevents deformation of the roving webs 20. Accordingly, the bearing structures 14, 16 constructed therewith are of high quality.

Figure 5 shows a cross-sectional view on an enlarged scale of an one possible embodiment of a prefabricated component 24. As can be seen from this Figure, this prefabricated component 24 can again be made up of roving webs 20 and epoxy resin 22. It will be noted however that ~~it~~-the prefabricated component 24 is already in the finished hardened condition at the ~~moment of~~ fitment-time it is placed into the bearing structure 14, 16, ~~but~~ and by virtue of the

selection of material involved it results in an integral and intimate join-in-structure with the bearing structure 14, 16 and the strands 20 according to the invention and thus ensures a satisfactory flow of force.

Figure 6 shows a second embodiment of a bearing structure 14, 16 according to the invention. In this case, the arrangement of the roving webs 20 between the prefabricated components 24 is not illustrated in this Figure, for simplification purposes. It can also be seen from this Figure that the prefabricated components 24 are here not arranged in individual columns one below the other but are arranged in displaced row-wise relationship with each other.

10 This arrangement results in even better strength for the bearing structure 14, 16 according to the invention.

The rotor blade according to the invention is distinguished by a considerably better level of stability by virtue of the use of the prefabricated components. In this case tensile forces can be absorbed, which are markedly
15 higher than in the case of previous rotor blades.

The bearing structure is therefore made by providing shells 11 and 12 into which the bearing structures are placed. The bearing structures have wet strands 20, namely, strands that are impregnated with a liquid hardening composite material that is not yet dry. Adjacent to the wet strands 20, a plurality of prefabricated, stiff components 24 are placed. The entire combination is enclosed in an epoxy resin 22 that may, or may not include some fiber glass or other fiber material. The combination of the strands 20, epoxy resin 22 and prefabricated stiff components 24 harden together into an integrated bearing structure 14. A configuration of the invention has been described hereinbefore by means of a rotor blade, as a possible option for a shaped body. ~~Instead of~~ Besides just a rotor
25 blade, the invention can also be very advantageously used for aircraft airfoils, ships and other shaped bodies, in respect of which, with a high level of strength, a high dynamic load-bearing capacity is nonetheless required.

All of the above U.S. patents, U.S. patent application publications, U.S. patent applications, foreign patents, foreign patent applications and non-patent publications referred to in this specification and/or listed in the Application Data Sheet, are incorporated herein by reference, in their entirety.

- 5 From the foregoing it will be appreciated that, although specific embodiments of the invention have been described herein for purposes of illustration, various modifications may be made without deviating from the spirit and scope of the invention. Accordingly, the invention is not limited except as by the appended claims.